Preliminary Capping Chemical Isolation Evaluation

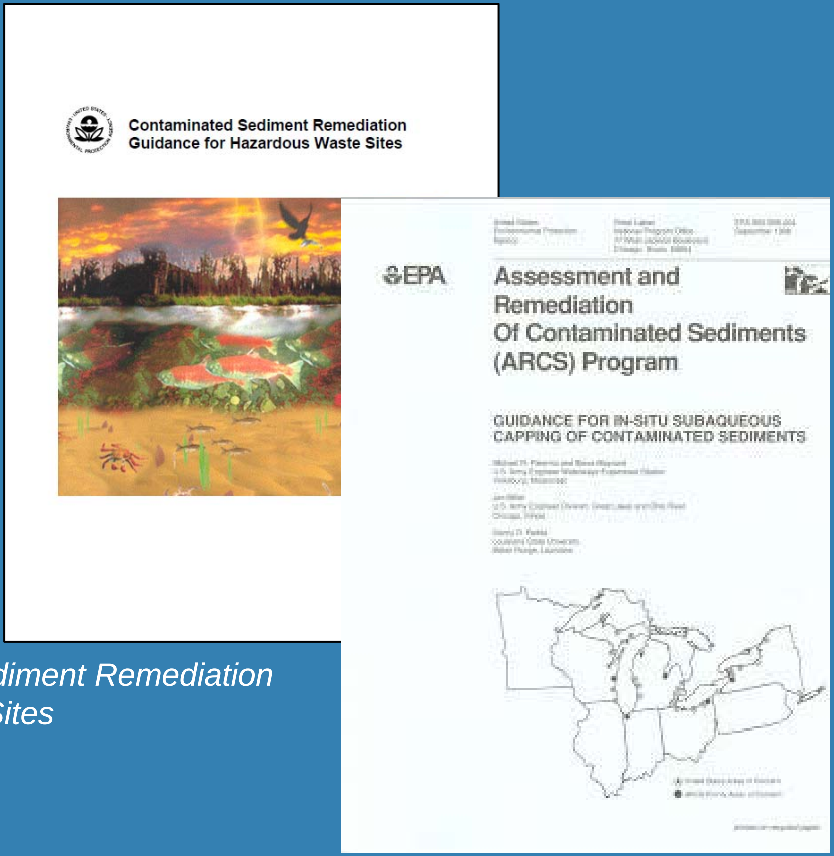
December 14, 2010

Presentation Overview

- Objective: Present methods used to screen potential capping areas and assess cap chemical isolation effectiveness
- This presentation does not address cap costs or implementability issues (e.g., navigation constraints and erosion potential)
- Key Findings:
  - EPA Region 10's suggested evaluation approach has the result of screening out capping over large site areas with low chemical concentrations. This approach is not consistent with capping decisions in the Northwest and across the U.S.
  - Guidance-based evaluation approach is consistent with national Corps and EPA sediment guidance, is protective and consistent with ARARs, and supports that capping is a viable site wide technology in terms of effectiveness
- All analyses are preliminary and subject to change in alternatives screening

Cap Functions

- Physical isolation
- Stabilization
- Chemical isolation – focus of this presentation



USEPA. 2005. *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites*

Palermo, M., Maynord, S., Miller, J., and Reible, D. 1998. "Guidance for In-Situ Subaqueous Capping of Contaminated Sediments," EPA 905-B96-004, Great Lakes National Program Office, Chicago, IL.

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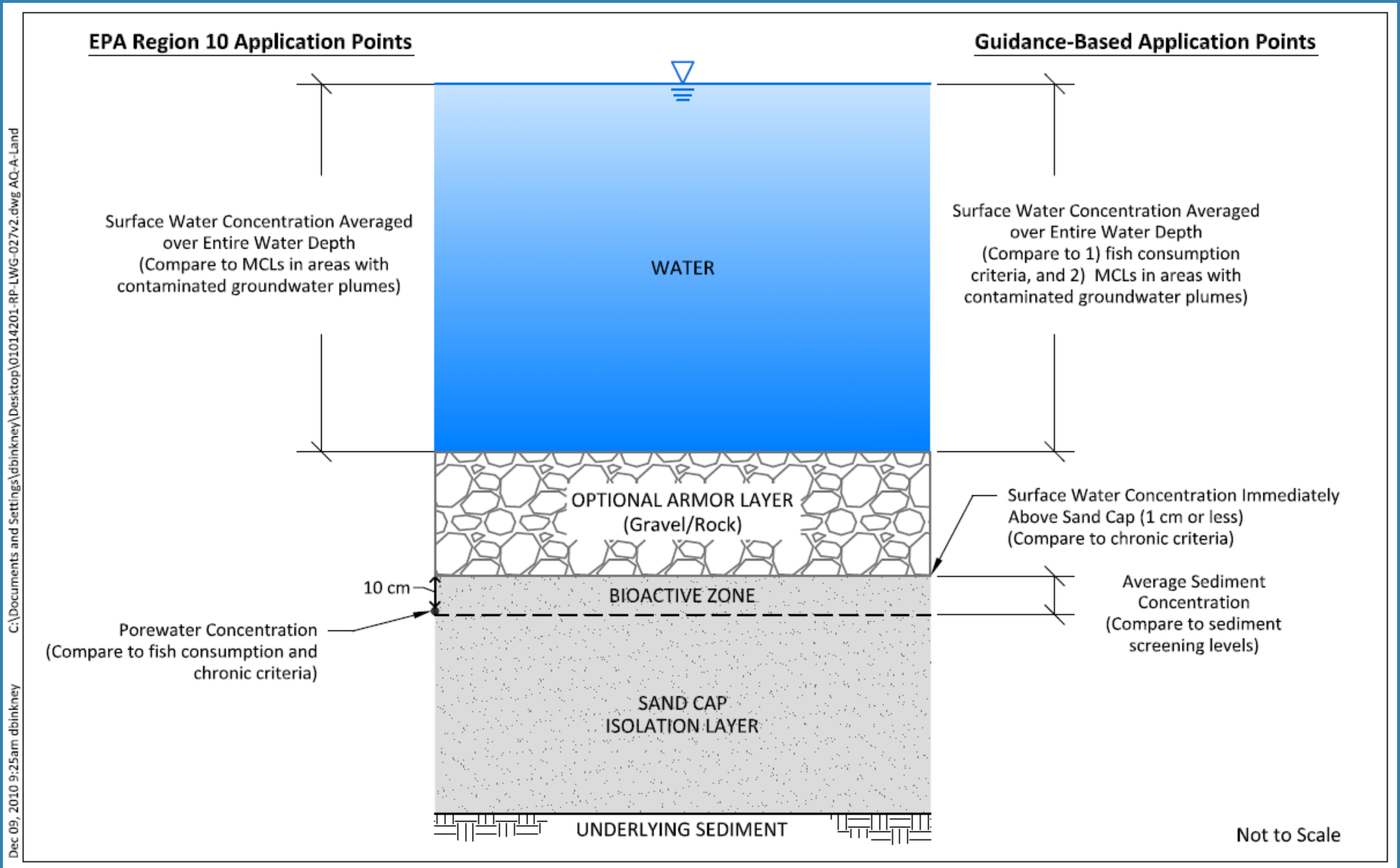
Chemical Isolation Modeling Approaches

- Use screening-level model to evaluate transport within the cap
- Compare model results to:
  - EPA Region 10 direction on water quality criteria and their application
  - Guidance-based alternative application of the criteria
- Approach consistent with resolution of EPA comments on CDF performance standards
- Guidance-based approach is protective and consistent with
  - EPA sediment remediation guidance
  - Typical application of water quality criteria in general
  - Cap evaluations elsewhere
- Both approaches are for screening evaluation comparison purposes only. They are not:
  - Cap performance criteria
  - Post-construction monitoring methods

Application of Screening-Level Capping Criteria



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Rationale – Guidance-Based Approach

- Fish consumption criteria – To be consistent with intent and normal use of the criteria, criteria should be compared to water column concentrations that account for:
    - Fish moving through the water column
    - Fish moving over large areas
    - People consuming fish over large areas

- MCLs – Consistent with possible water withdrawal scenarios, criteria should be compared to water column concentrations averaged over the well mixed water column
    - Note EPA has already accepted that comparisons to MCLs should be conducted on a vertically integrated basis and only in areas of contaminated groundwater plumes.

Rationale – Guidance-Based Approach (cont.)

- Chronic criteria – For screening purposes, compare to a maximum single location 1 cm above the cap isolation layer because some epibenthic aquatic species are relatively stationary (although population exists over larger area)
  - Benthic species (within cap sand) are covered by potential sediment screening levels
  - Conservative for fish, which would live on/above cap armor
- Sediment Screening Levels - Provides a method to assess exposure to porewater as well as bulk sediment that is consistent with the basis of the cleanup decisions
  - FS will use sediment screening levels that are protective of bioaccumulation and direct contact pathways for people and benthic organisms
  - EPA’s PRGs used as a screening evaluation here
  - The LWG does not endorse the use of EPA’s PRGs beyond this screening

Sediment Screening Levels Used in Evaluation

	PRG for Screening (Based on Focused PRGs)				PRG for Benthic Screening Only		
Chemical	Sediment PRG	Units	Source of PRG	Notes	Sediment PRG	Units	Source of PRG
4,4'-DDD	28	µg/kg	Eco Benthic - PEC SQG (Sum DDD)	PRG is for Sum DDD. No 4,4 DDE PEC available.	28	µg/kg	Eco Benthic - PEC SQG (Sum DDD)
4,4'-DDE	3.1	µg/kg	HH Adult Fish Consumption, 10^-6 Large Home Range Fish, Low BA, Low IR		31.3	µg/kg	Eco Benthic - PEC SQG (Sum DDE)
4,4'-DDT	62.9	µg/kg	Eco Benthic - PEC SQG (Sum DDT)	PRG is for Sum DDT. No 4,4 DDT PEC available	62.9	µg/kg	Eco Benthic - PEC SQG (Sum DDT)
Arsenic	3.97	mg/kg	Background DW UPL	Flag if it drives analysis.	17	mg/kg	Eco Benthic - PEL
Benzene	--	--	No focused PRG				
Benzo(a)pyrene	423	µg/kg	HH Tribal Fisher In-water Direct Contact 10^-6 (BaP)	PRG is the same for B(a)P and for B(a)PEq. Use everywhere except beach areas and in navigation channel.	1450	µg/kg	B(a)P Eco Benthic - PEC SQG
Benzo(a)pyrene	162	µg/kg	HH HF Fisher Beach Sediment Direct Contact 10^-6 (BaP)	PRG is the same for B(a)P and for B(a)PEq. Use in beach areas only.			
Benzo(a)pyrene	1450	µg/kg	B(a)P Eco Benthic - PEC SQG	In navigation channel only since lower PRGs drive in all other locations. Since focused PRG is a PEC, use Benzo(a)pyrene PEC for single chemical			
Bis(2-ethylhexyl) phthalate	--	--	No focused PRG				
Chlorobenzene	--	--	No focused PRG				
Copper	149	mg/kg	Eco Benthic - PEC SQG	Eco Benthic FPM High PRG = 562 mg/kg also is on PRG list.	149	mg/kg	Eco Benthic - PEC SQG
Mercury	0.41	mg/kg	Eco Benthic - FPM High SQG		0.41	mg/kg	Eco Benthic - FPM High SQG
Naphthalene	561	µg/kg	Eco Benthic - PEC SQG Napthalene	Focused PRG is for LPAH. No FPM exists for Naphtalene. Use the PEC for Napthalene instead since the PEC was used	561	µg/kg	Eco Benthic - PEC SQG Napthalene
Total PCBs	29.5	µg/kg	HH Adult Fish Consumption - Small Mouth Bass - Low IR - 10^-4		500	µg/kg	Eco Benthic FPM SQG
Vinyl chloride	--	--	No focused PRG				
	Notes:						
	B(a)P Clam Consumption PRG not included in this analysis due to future institutional controls on collecting clams in a cap.						
	PRGs for the some chemicals are the same for both screenings.						

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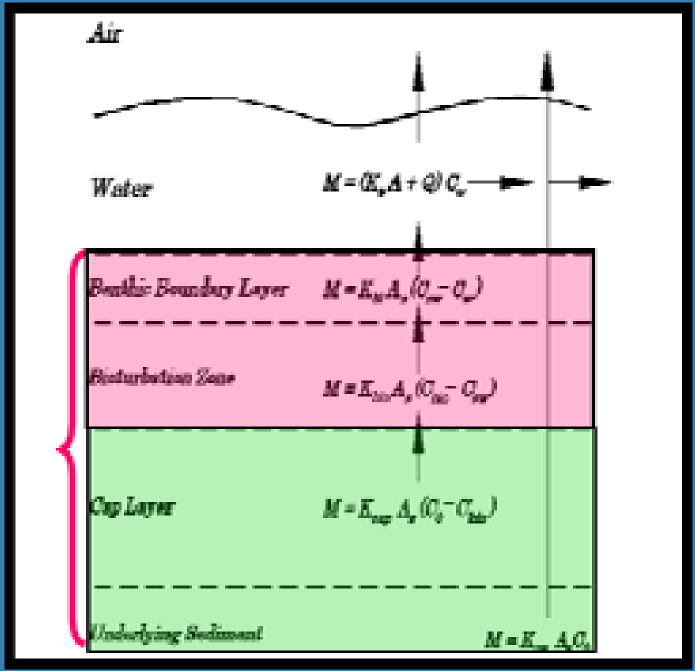
Cap Modeling Approach

- Initially make simple, conservative assumptions to see if results indicate capping effective
  - Such assumptions likely do not reflect actual conditions that could be evaluated on a site-specific scale
  - Simplifies analysis for a large diverse site
- If initial conservative approach indicates unfavorable results, additional evaluation on actual conditions should be conducted
- Therefore, used two phased approach
  - Phase 1 preliminary “screening” – conservative and not a final decision
  - Phase 2 refined evaluation for areas highlighted in Phase 1 for additional evaluation

Cap Modeling Approach

- Used Steady-State Cap Model (Reible)
- Established appropriate broadly applied input parameters
- Evaluated 12 chemicals from across site
  - These are “indicator chemicals” based on potentially high toxicity, mobility, or persistence
  - Ongoing evaluations may identify one or two additional chemicals for some site-specific situations
- Phase 1 - Evaluate maximum existing surface sediment concentrations that can be capped at range of potential cap thicknesses
  - Conservative screening level evaluation that uses conservative, simplified assumptions
  - Higher sediment concentrations may be “cap-able” upon further evaluation using more detailed analysis (see Phase 2)
- Map maximum concentration Phase 1 results using GIS (natural neighbor contours)

Steady-State Model (Reible)



- Steady-state model incorporates
  - Advection
  - Diffusion
  - Bioturbation
  - Biological decay
- Open source code available at http://www.ce.utexas.edu/reiblegroup/downloads.html
- Widely used for screening purposes and consistent with Corps and EPA capping guidance

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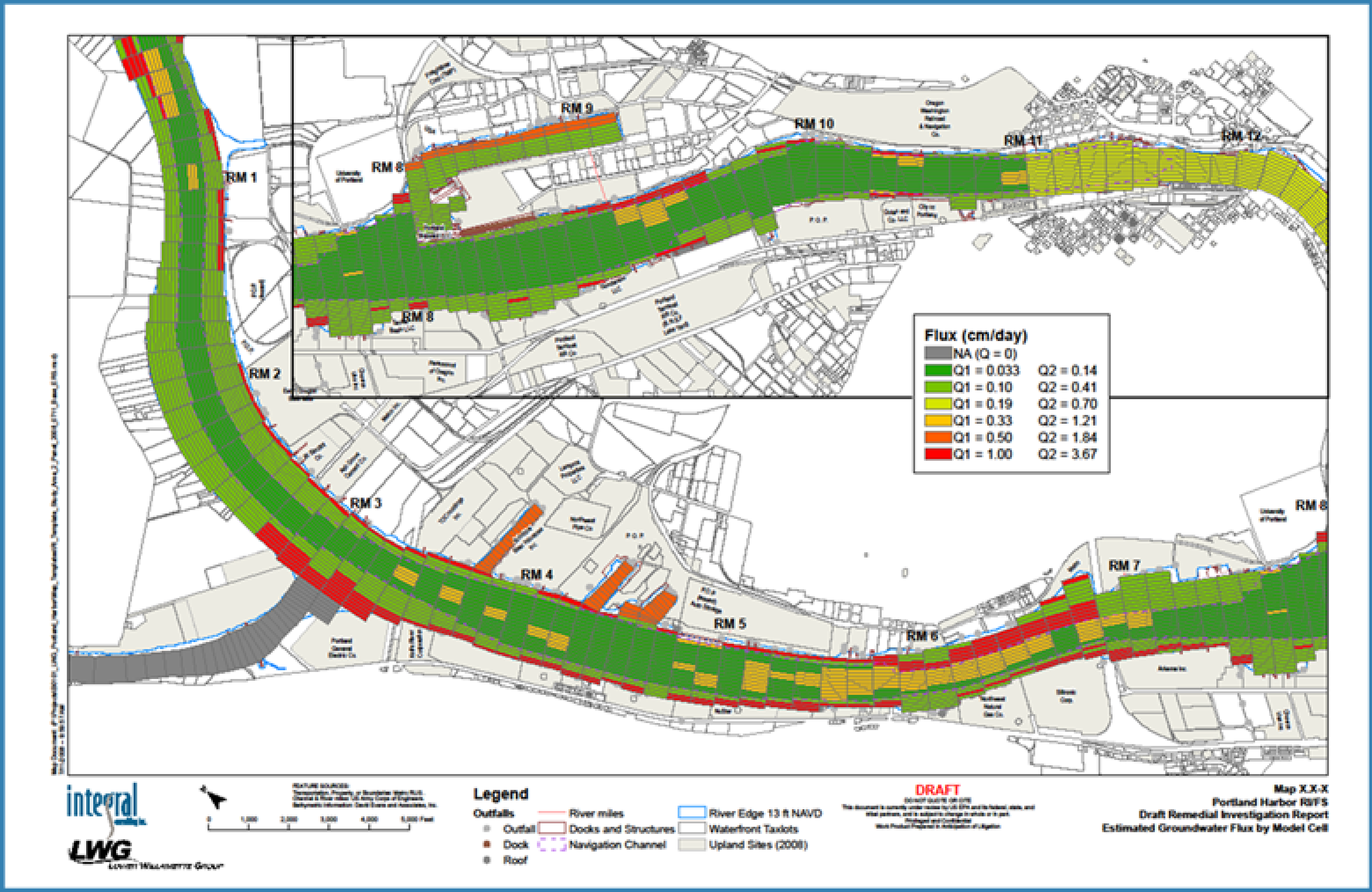
Phase 1 - Key Model Input Parameters

- Isolation layer sand properties
  - Porosity (0.4 – typical for clean cap sand)
  - TOC (<0.1% - typical for clean sand cap)
- Partition coefficients
  - Comprehensive review of literature values
  - Similar to the MNR modeling
- Biodegradation rates
  - Comprehensive review of literature values for guidance-based approach
  - Assumed zero for EPA Region 10 initial recommendation

Phase 1 - Key Model Input Parameters (cont.)

- Groundwater Darcy Velocity
  - Expanded RI Groundwater analysis and applied to grid across the Site
- Underlying sediment concentration
  - Model computed this value by chemical to determine “cap-able” surface sediment concentrations
  - Partitioning assumptions used
- Depositional velocity
  - Conservatively assumed to be zero
- Bioturbation layer thickness
  - 10 cm per EPA December 2009 comments

Phase 1 - Darcy Velocity Used in Cap Model



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Chemicals Evaluated Using Cap Model

- Arsenic
- Copper
- Mercury
- Benzo(a)pyrene
- Naphthalene
- Bis(2-ethylhexyl) phthalate
- 4,4'-DDD
- 4,4'-DDE
- 4,4'-DDT
- Total PCBs
- Benzene (SMA14)
- Chlorobenzene (SMA14)

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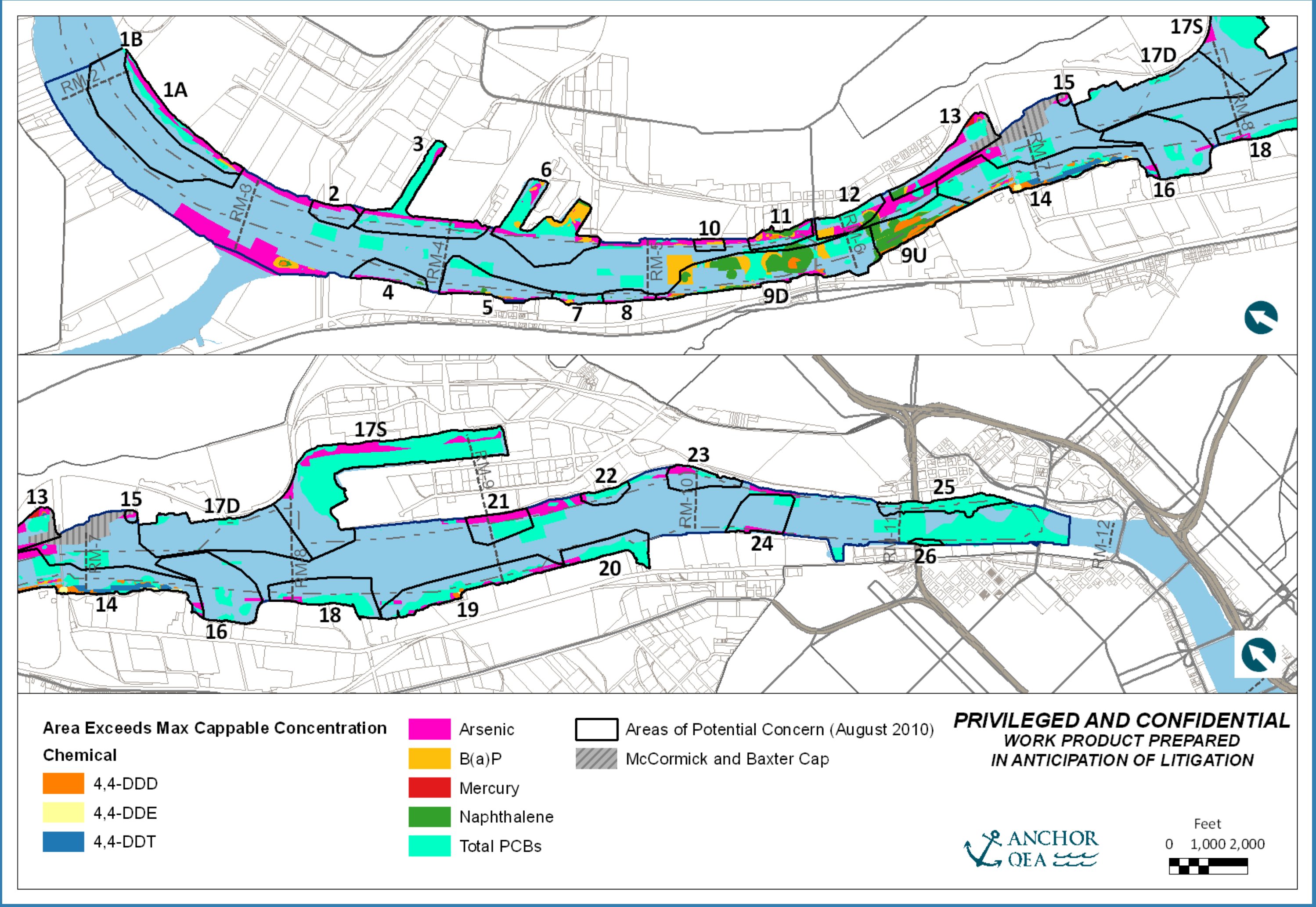
Phase 1 - Chemical Isolation Screening Results

- Because model is steady-state, little difference in maximum concentrations between cap thicknesses ranging from 12-inch to 72-inch
- Cap thickness increases time to steady-state
- For 12-inch cap, time to steady-state is very long in many cases (greater than 500 years)
- Mapping based on 12-inch thick chemical isolation
- EPA Region 10 Phase 1 conservative screening level approach identifies large areas where typical capping would not meet EPA criteria.
  - For example, concentrations above 3 to 800 ppb PCBs are not “cap-able” under this approach
- Guidance-based Phase 1 conservative screening level approach identifies most of the site as “cap-able” (in terms of chemical isolation effectiveness) with a few small areas requiring further Phase 2 evaluation

Phase 1 Chemical Isolation Screening Results (1 ft isolation layer) – EPA Region 10 Approach



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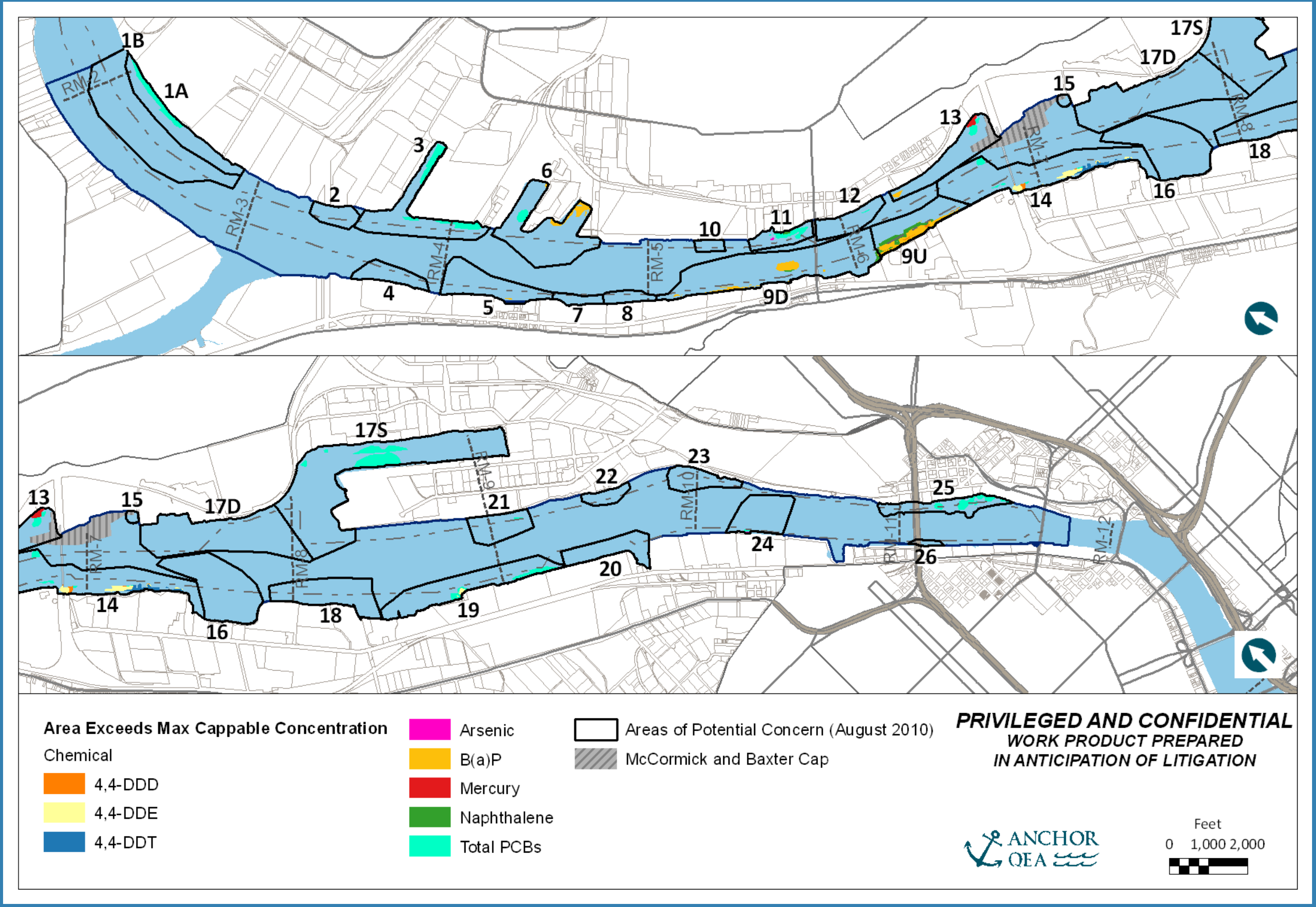
Phase 1 Chemical Isolation Screening Results (1 ft isolation layer) – Guidance-Based Approach



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Phase 1 Chemical Isolation - Surface Water Comparison

- Guidance-based approach compares fish consumption criteria and MCLs (in contaminated groundwater plume areas) to results estimated in the water column
- Mixing calculation performed for screening-level analysis SMAs representing a range of river water velocities and mixing conditions
  - SMAs 6, 12, 15, 17S, and 20

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Phase 1 Surface Water Comparison (cont.)

- Approach:
  - Obtained average velocity and water depths from EFDC hydrodynamic model for each SMA
  - Computed loading to the SMA through the cap assuming average surface sediment concentration in SMA
  - Computed concentration in water column over SMA
  - Compared results to fish consumption criteria or background values (when background was higher than criteria)
- Screening-level results indicate that fish consumption criteria would be met everywhere in the water column

Phase 2 Chemical Isolation Evaluation

- Using guidance-based Phase 1 approach several small areas exceeded maximum concentrations
  - Ranged from 0.001 acres (100 ft^2) to 4 acres
- LWG has performed Phase 2 evaluations on these areas
  - Sensitivity of Darcy velocity
  - Active capping (e.g., addition of activated carbon or organoclay layers)
- Additional evaluation of conditions and capping approaches in these areas are being considered
- Conclusion is that capping is a viable site wide technology in terms of chemical isolation effectiveness

Comparison to Other Sites

- EPA Region 10 approach maximum “cap-able” sediment concentrations (high - low Darcy velocities):
  - Total PCBs: 3 - 800 ppb
  - Benzo(a)pyrene (PAHs) 750 - 182,000 ppb
- Other sites:
  - PCBs Lower Fox River (Green Bay) – 2,000 to 50,000 ppb
  - PCBs West Waterway Prototype CAD (Seattle) – 3,100 ppb
  - PCBs Denny Way CSO (Seattle) – 950 ppb
  - PCBs Piers 53-55 CSO (Seattle) – 1,100 ppb
  - PCBs St. Lawrence River GM (Massena) – 10,000 ppb
  - BaP One Tree Island CAD (Olympia) – 15,000 ppb
  - LPAH St. Paul Waterway Cap (Tacoma) – 47,000 ppb
  - TPAH Eagle Harbor West OU (Bainbridge) – 10,000 ppb
  - TPAH Middle Waterway (Tacoma) – 5,000 ppb
  - TPAH St. Lawrence River Reynolds (Massena) - 250,000 ppb
  - cPAH McCormick and Baxter (Portland) – >2000 ppb

Presentation Conclusions

- EPA Region 10 evaluation approach
  - Unnecessarily screens out capping over large site areas with low chemical concentrations
  - Is inconsistent with capping decisions at other sites in the Northwest and across the U.S.
- Guidance-based evaluation approach
  - Is consistent with national Corps and EPA sediment guidance
  - Is protective and consistent with ARARs
  - Indicates capping is a viable site wide technology in terms of chemical isolation effectiveness
- All analyses are preliminary and subject to change in alternatives screening